FINISHING THE COMPOSITE AIRCRAFT

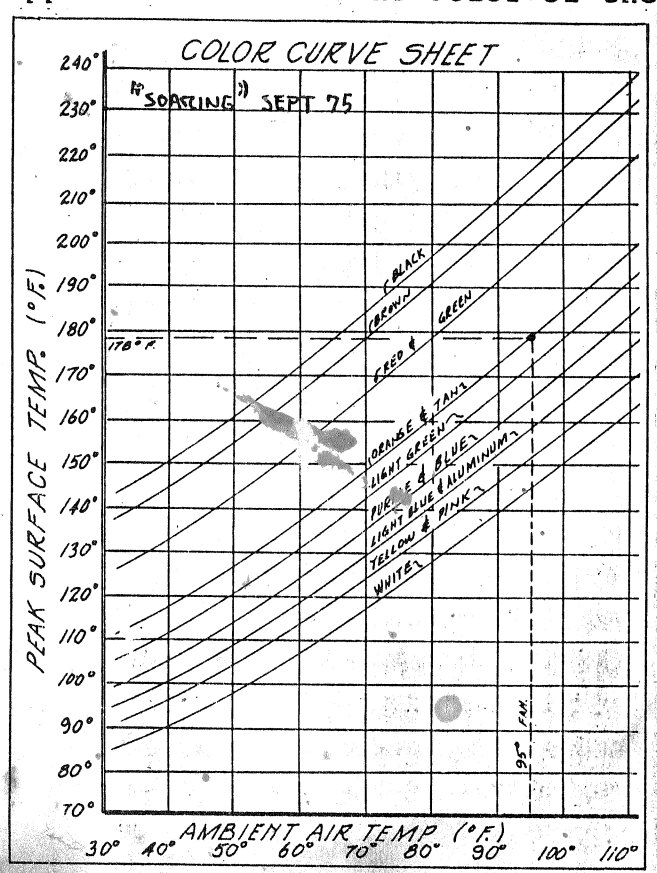
SECTION V OF THE VARIEZE MANUFACTURING MANUAL

INTRODUCTION

Finishing the composite airplane is quite a bit more important than simply obtaining an attractive paint job. The finish on a composite aircraft serves to protect the structure from weathering and deterioration from ultra violet radiation (sunlight). The finishing materials also give the airplane its final aerodynamic shape. Using the proper materials and techniques, the finishing process is fast, pleasing (both esthetically and aerodynamically), and provides for long maintenance-free service. Use of sub-standard materials can limit the life of the finish, result in an overweight airplane, or even limit the service life of the airframe. Sanding is done constantly during the finishing process and extreme caution must be exercised to avoid damaging the structure. A poorly executed finishing job can destroy the structural integrity of the airframe. Even the finished color of the composite aircraft can effect its structure. The finishing process is as important to the structure of the composite airplane as basic materials and techniques used in fabrication are. Proper techniques must be adhered to for safety as well as to obtain an attractive airplane.

FINISH COLORS AND HEAT

The materials used in amateur-built composite airframes are predominately epoxy resin systems with fiberglass reinforcement over a variety of plastic foam cores. The epoxies and the foams are all sensitive to high temperatures. Some epoxies, cured at elevated temperatures, retain their physical strength to temperatures not found outside an oven. Others, including most room temperature curing epoxies such as the RAES and RAEF systems, soften and loose their rigidity at only moderate temperatures. The common plastic foams are also heat sensitive and tend to soften and (some) swell with moderately elevated temperature. Elevated temperatures could potentially cause a softening of the fiberglass load bearing material, a swelling of the foam core, and general distortion of the airframe. To achieve elevated temperatures you would have to bake your airplane or find some other means of heating it. The sun is a potential source for this heat. In still air, on a hot sunny day it is possible to obtain surface temperatures that approach 250° F. The color of the surface determines how much solar heat it will absorb. White surfaces absorb very little (10%) of the sun's heat while a black surface (95% absorbsion) will heat up tremendously. The accompanying graph shows the relationship between color and surface temperature. White has been choosen as the standard color for fiberglass sailplanes to preclude any possibility of excess temperature due to solar heating. The same criteria apply to the VariEze and VariViggen SP wings, and white is the recommended color for these aircraft. Trim colors in non-critical areas are acceptable as desired. Such as the fuselage, vertical winglet surfaces, and the underside of wings and canard. Dark trim colors are definately not recommended on the upper surface of the wings and canard. If you would like further information on the subject read the September 1975 issues of "Soaring" magazine.



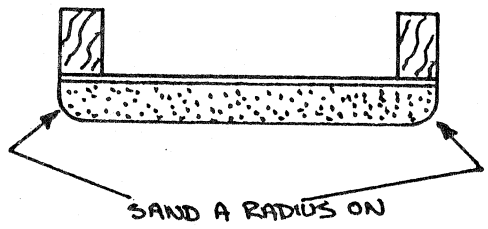
TOOLS AND MATERIALS

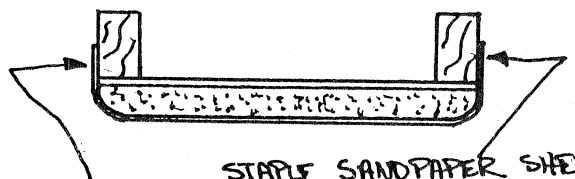
The tools and materials used in finishing the composite airplane are simple and straight foreward. A low density microsphere/epoxy mixture (dry micro) is used for coarse filling requirements. Automotive type polyester body fillers (Bondo) are very heavy and not recommended for aircraft finishing work. Medium to light surface filling (less than .030 in) is done with a light weight polyester spray (or brush) filler/primer called Feather-Fill. Feather-Fill is noteworthy for its ability to fill medium thicknesses in a single spray or brush coat and for its easy sanding to a smooth surface. Dupont 70S dark gray laquer primer/surfacer provides an effective ultra violet radiation barrier with its 15% carbon black content as well as an excellent finish sanding surface in preparation for the finish paint. The actual finish paint type is largely a matter of the builder's personal preference. Automotive finishes in laquer, enamel, acrylic laquers, acrylic enamels, and the polyurethanes are all acceptable. We find the acrylic laquer is easy to work with, easily patched and readily polished to a high gloss. One manufacturer is offering a special ultra violet barrier acrylic laquer finish white paint which will greatly enhance the protective qualities of the finish. The enamels and acrylic enamels are low cost and easy to apply, however, they are not readily repairable if chipped. The polyurethane finishes offer the best gloss for the longest life, but they are high cost and virtually impossible to repair. There is a polyester paint, known as Prestek, commonly used in sailplane circles to achieve a glass-smooth finish, but it is heavy, requires a tremendous amount of work to get a high gloss finish, and chips easily (brittle).

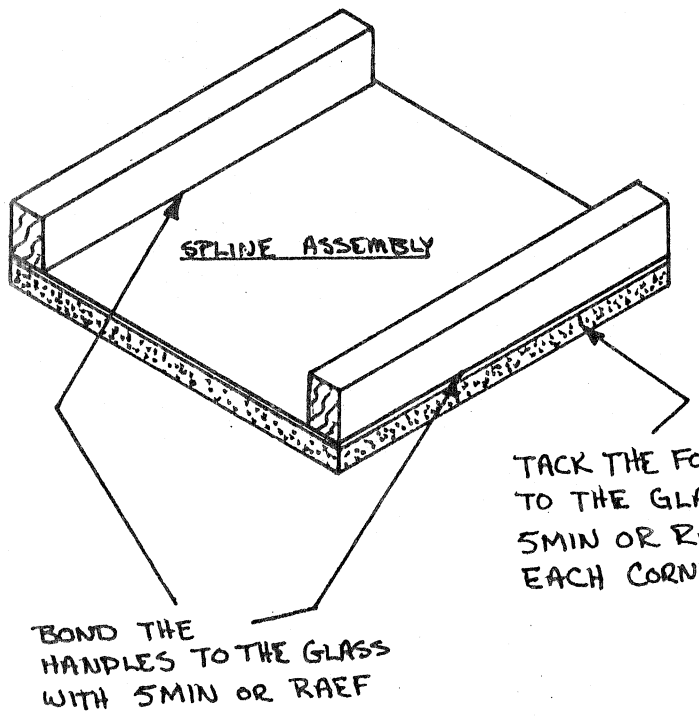
Sanding will occupy a large percentage of the time spent finishing the composite aircraft. Sandpaper in 36 to 60-grit, 100-grit, 220-grit, and 320-grit roughnesses will be used. Standard 9"x11" sheets are the most versitile. Use a good quality aluminum oxide, or silicon carbide sandpaper. Don't waste your money on the cheap flint-type sandpapers. Power sanders are not recommended; it is too easy to damage the structure while using them. Hard (wood) and soft (foam) sanding blocks and the sanding spline shown on page 2 will be your primary finishing tools. A paint spraying setup will be desirable for feather fill, U.V. barrier primer and finish painting. Some hand brushing of feather fill and U.V. primer will also be done

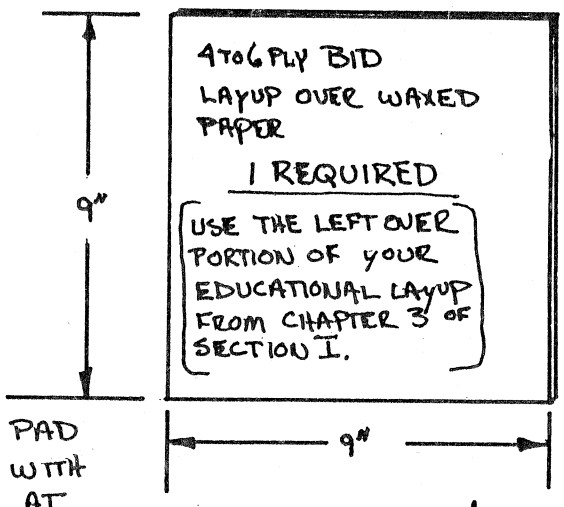
The Spline

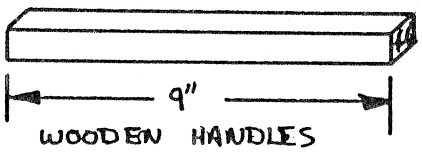
The sanding spline is a finishing tool common to the sailplane industry. It is an easy tool to make and does an excellent job of contouring. You may find it handy to make two, one for coarse grit sandpaper and one for medium or fine sanding. The spline is an easy tool to use but it may require your close attention at first. The spline is always held with handles parallel to the leading edge of an airfoil surface (wing, canard, etc.) as shown in the sketch. The sanding motion is on a diagonal to the leading edge while the spline's handles are held parallel. This takes a little getting used to but becomes second nature after a little practice.

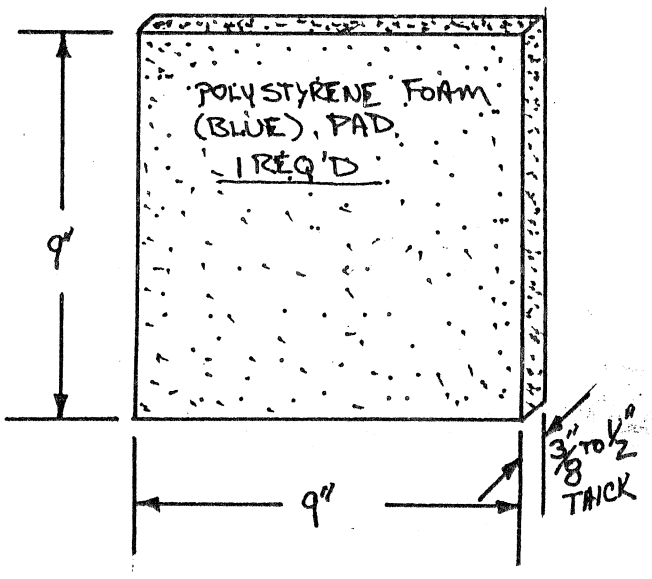


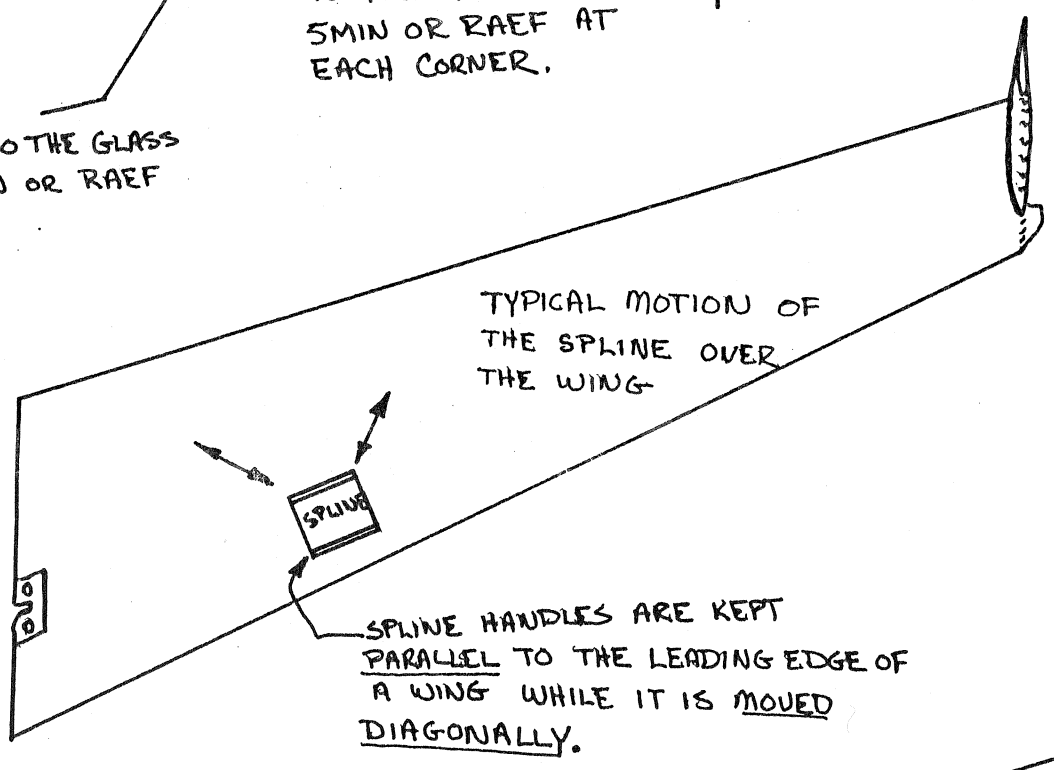








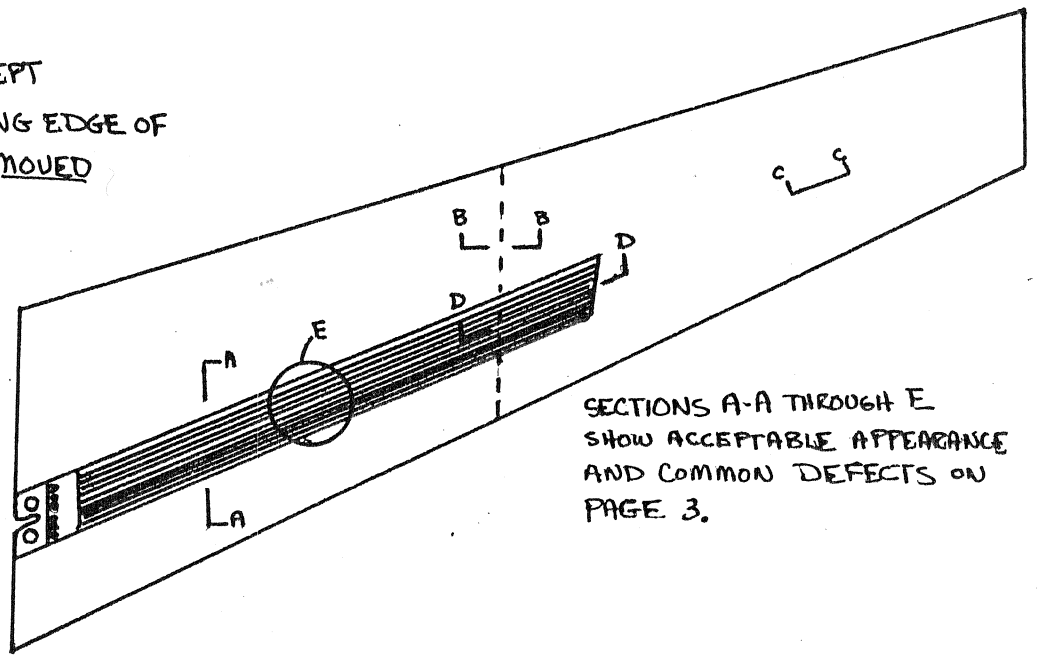




THE FINISHING PROCESS

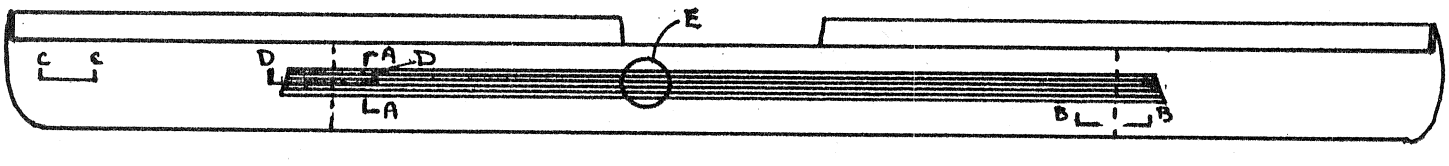
Finishing the composite airplane is a five-step operation. Repairs or rework of structure must be completed first before the obscuring finish is applied, and final structural inspe - tions must be complete. Second, coarse contour filling is done with microspheres/mixed with epoxy (dry micro) as required in areas requiring .03 inch to .20 inch of fill. Any exceptionally gross filling (over .20 in) is also accomplished at this stage using a foam filler. The initial contour sanding begins with the cured microsphere filler, and exceptional caution must be exercised to avoid damaging the structural skins while sanding. Third, featherfill is applied to fill medium sized surface defects up to .03, and as a general fill of the glass surface weave. The fourth step is the application of an ultra violet barrier primer. Fifth, the final finish paint is applied.

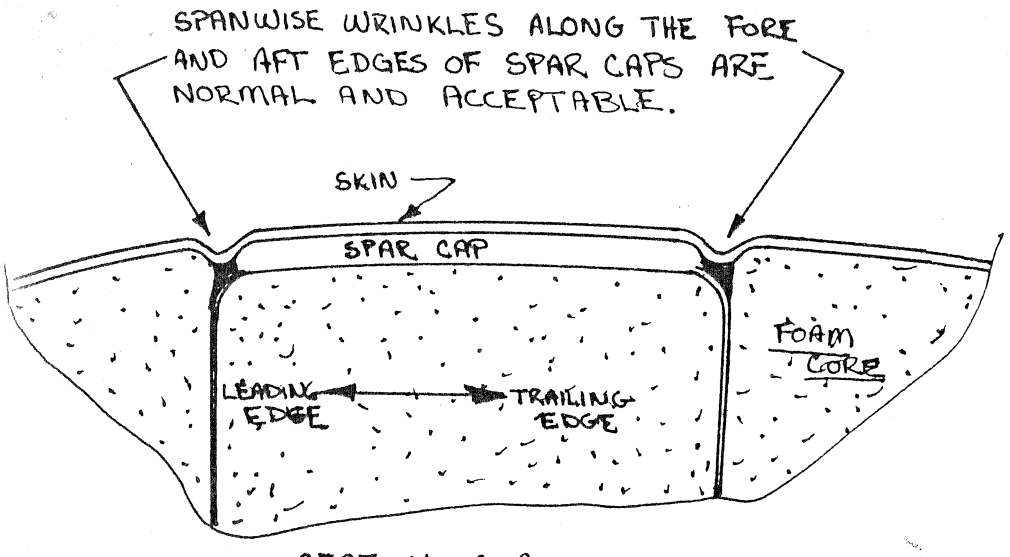
The following sketches are descriptive of the finishing process and its potential pit falls. The sketches are grossly exaggerated scale to show details more clearly.



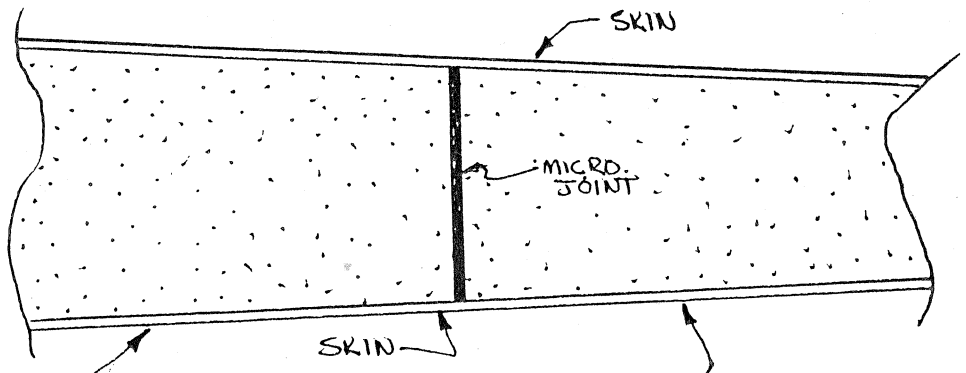
Step One; Inspection/Repairs

When you begin finishing, the entire structure must be airworthy. You can hide poor workmanship from your own eyes and from the inspector who will finally approve your first flight, but you can't fool mother nature! Everything has to be structurally sound before finish materials are applied. The following sketches are a review and clarification of the quality control criteria found in section I, chapter 3, and newsletter 10. Each airplane must have a thorough inspection and required repairs completed as the first step in finishing.

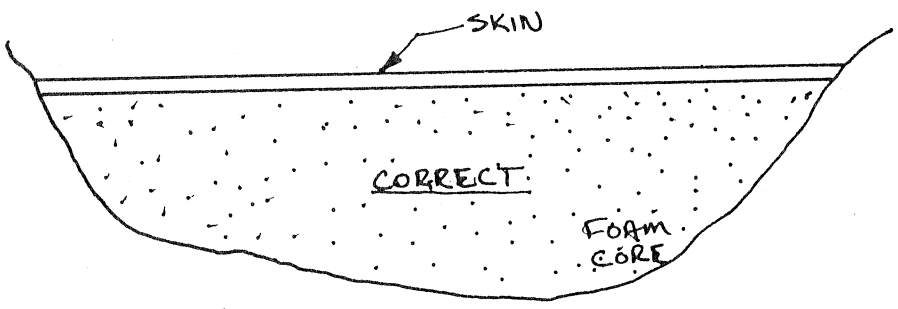




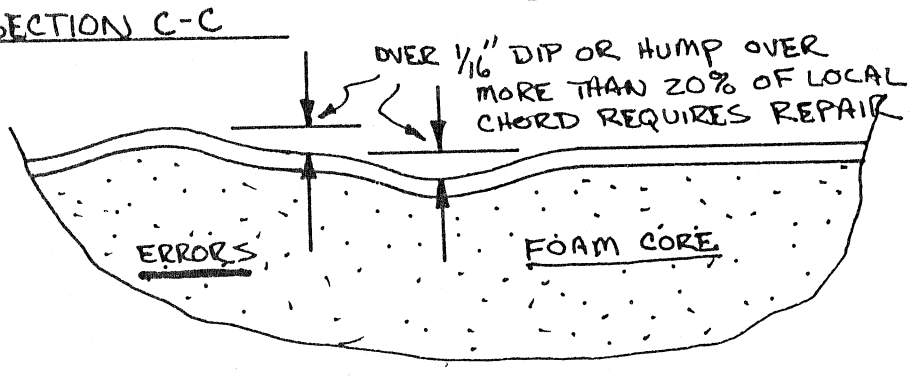
SECTION A-A

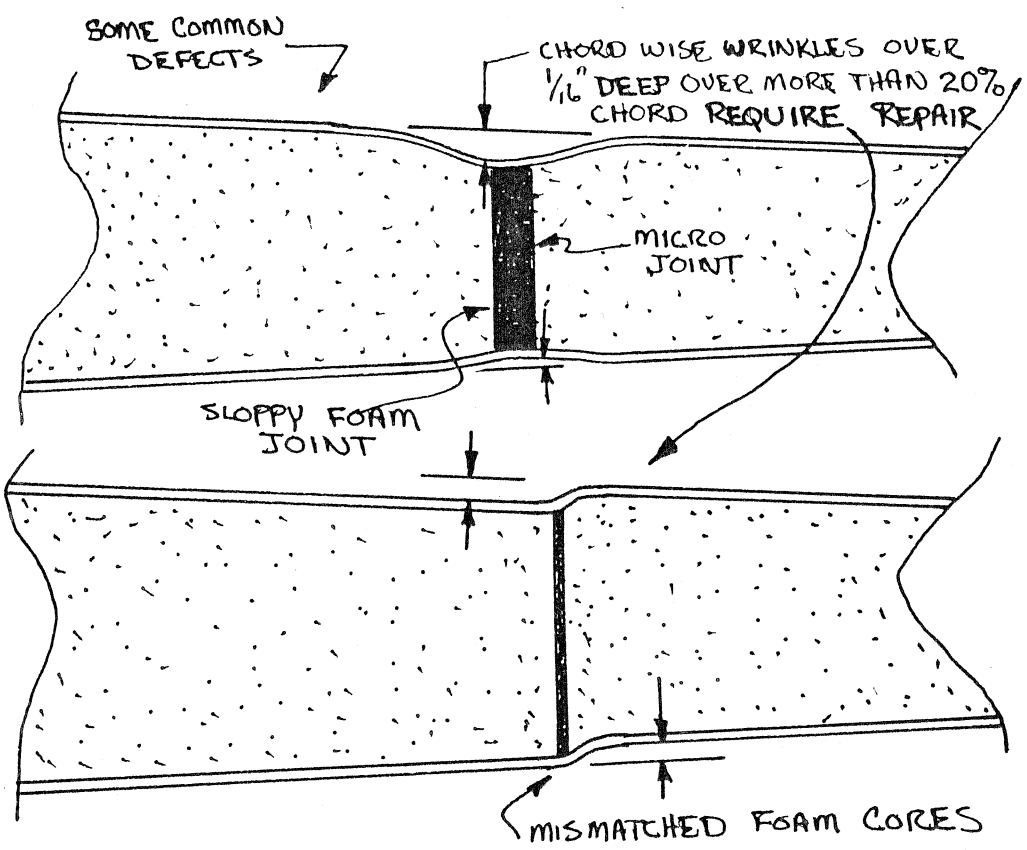


SECTION B-B DONE CORRECTLY

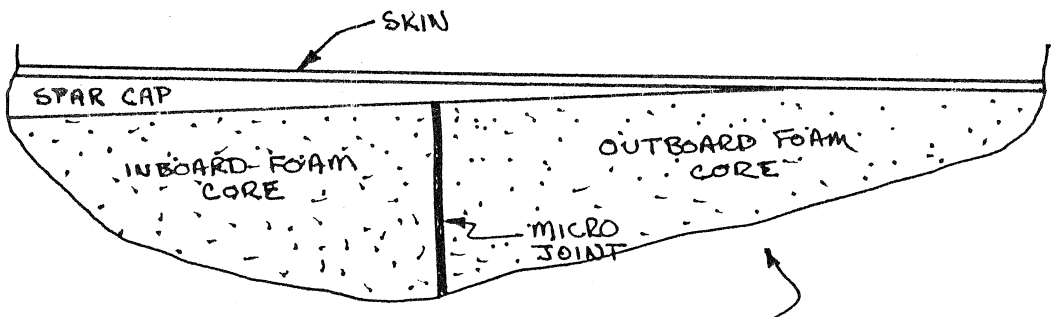


SECTION C-C

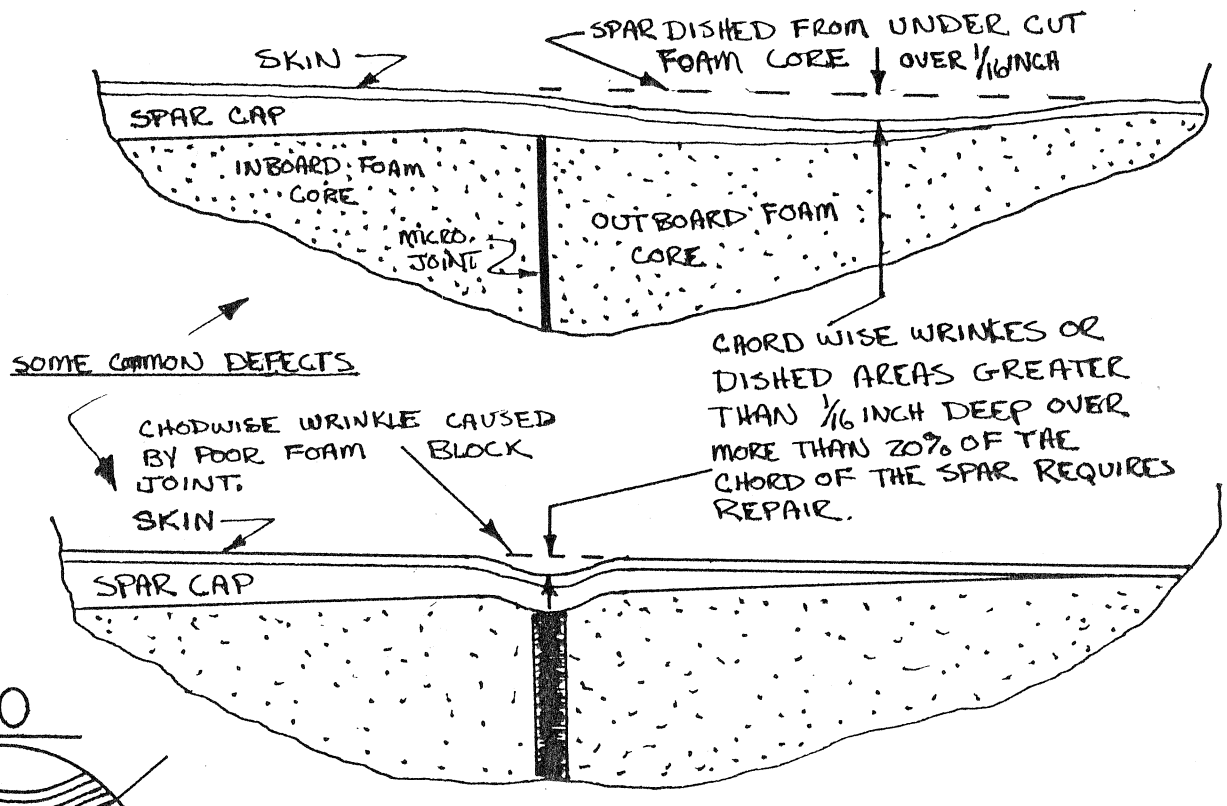


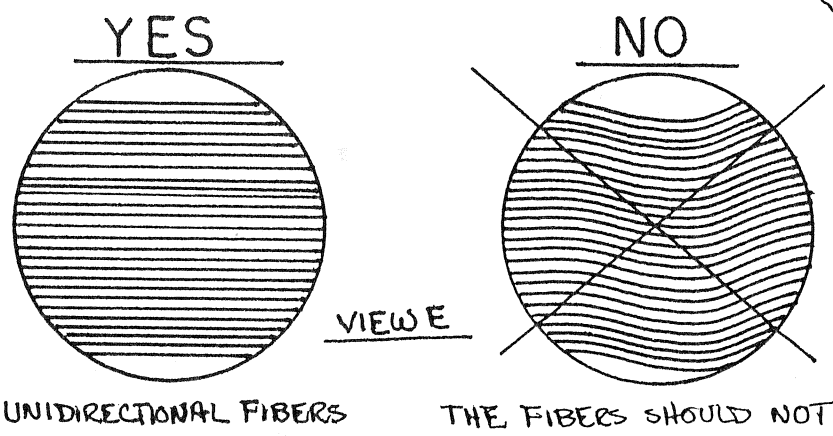


STEP ONE: DETAILED STRUCTURAL INSPECTION



SECTION D-D AS IT SHOULD BE





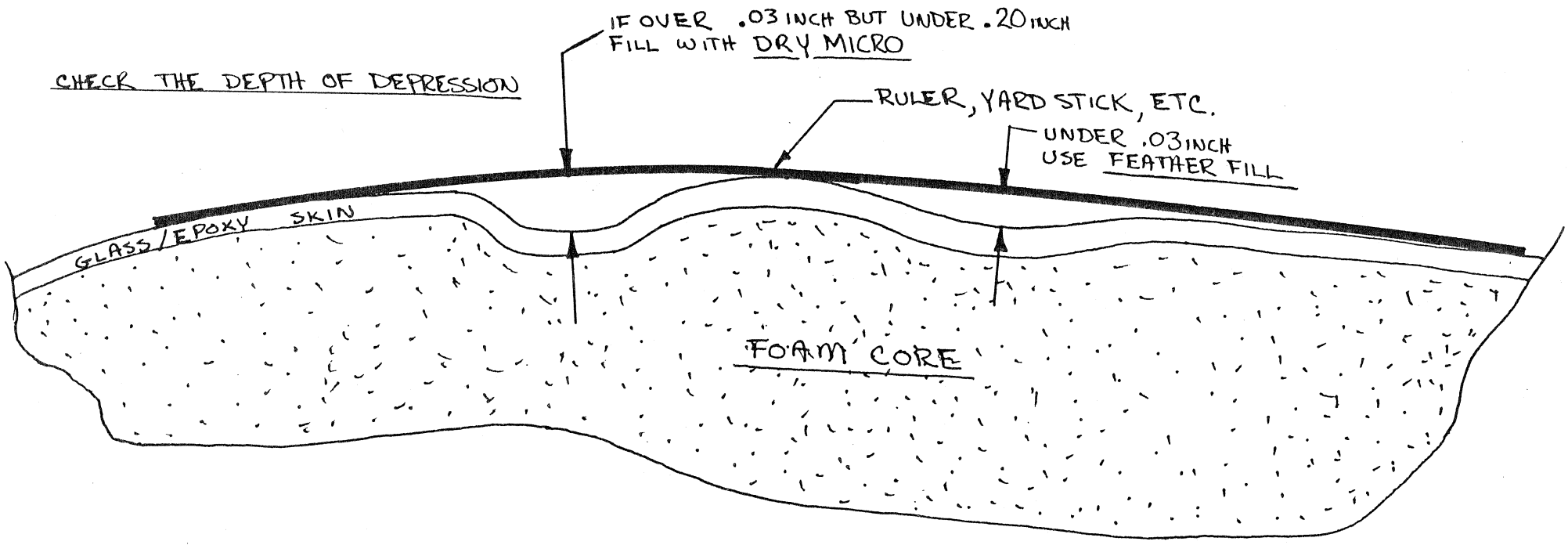
THE UNIDIRECTIONAL FIBERS SHOULD BE STRAIGHT AS SHOWN ABOVE

THE FIBERS SHOULD NOT BE DISRUPTED OR CROOKED AS SHOWN HERE.

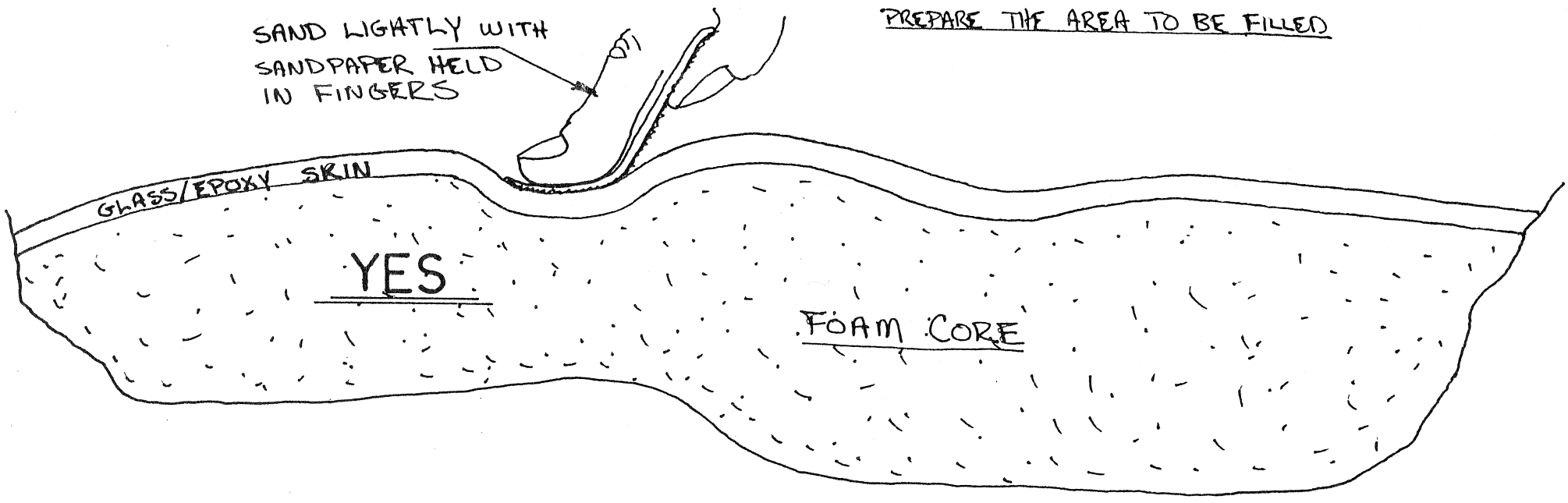
Step Two: Coarse Filling

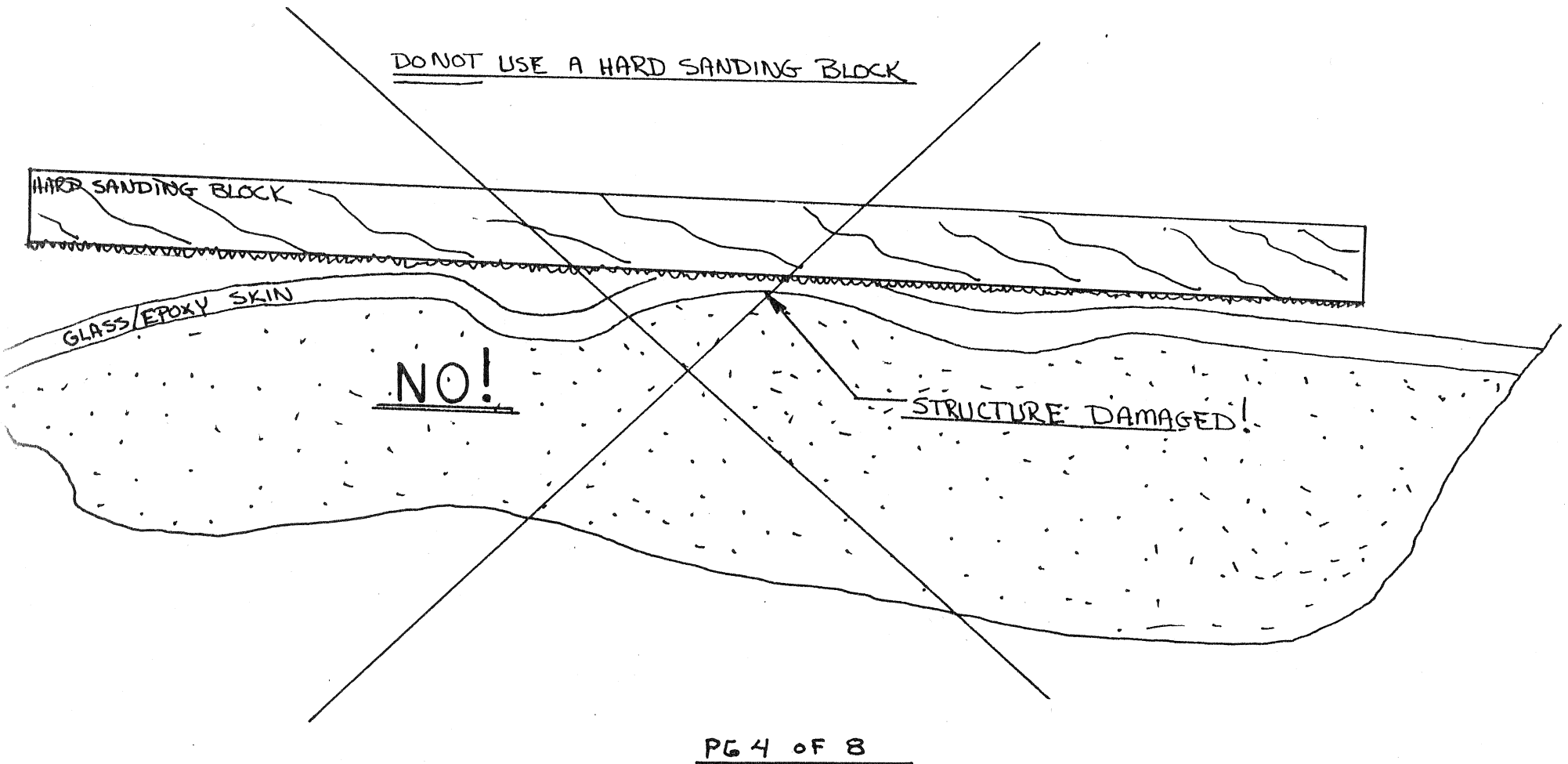
You must be extra cautious in this step or you may destory your structure. When you take a piece of sandpaper and start grinding on your composite structure it's like using acid to clean a metal wing spar. It must be done carefully!

Start by determining which areas require

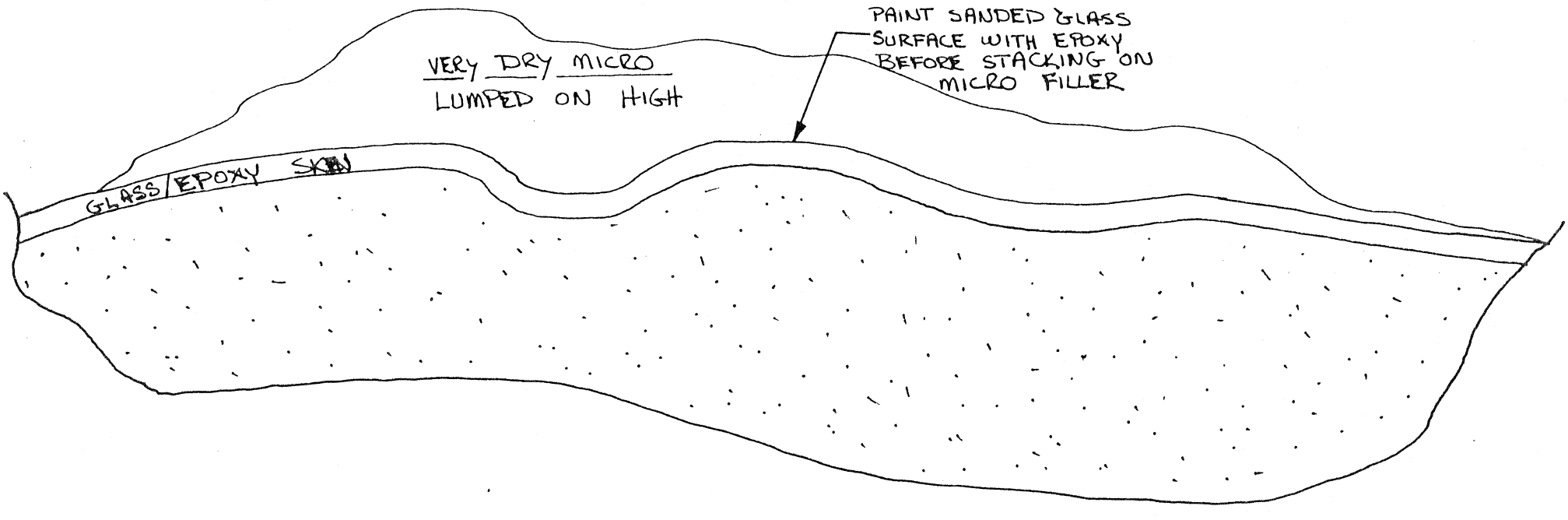


micro filler as shown using a flexible yard stick and a scale. Prepare the areas to be filled by hand-sanding lightly. Do not try to use a sanding block or spline on these areas.

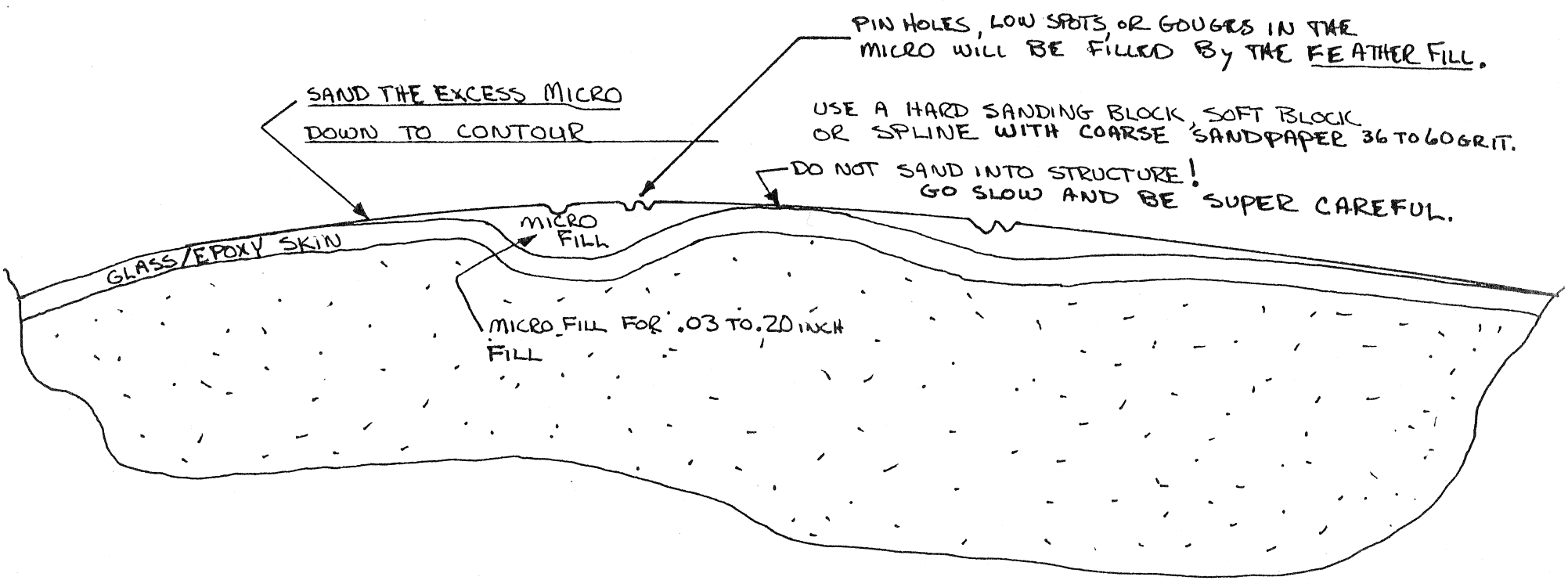




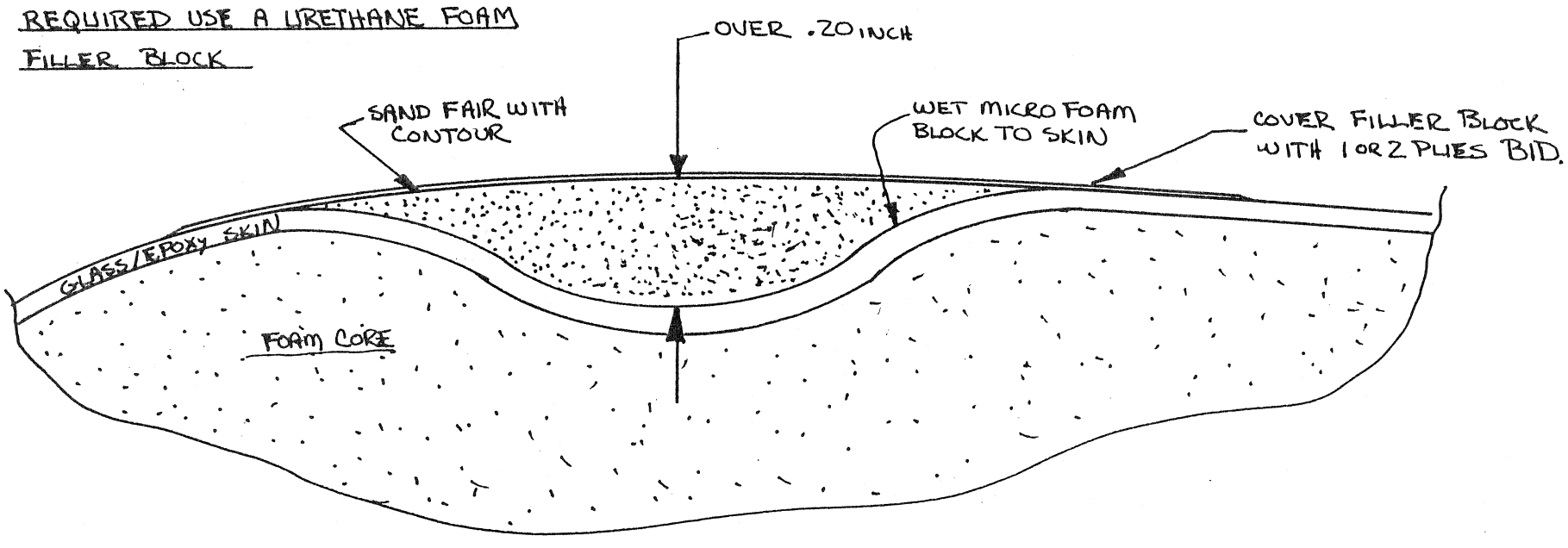
Paint a thin coat of epoxy over the area to be filled. Dry micro is then lumped over the area. The fill must be high, such that material is sanded away to bring the area into contour. The micro should be mixed very dry (lots of microspheres) to save weight). Let the micro cure at least 24 hours.



Sand the micro overfill into contour using a hard sanding block, or spline with coarse (36 to 60-grit) sandpaper. Exercise extreme caution while sanding. A few careless strokes with coarse paper can ruin your structure!



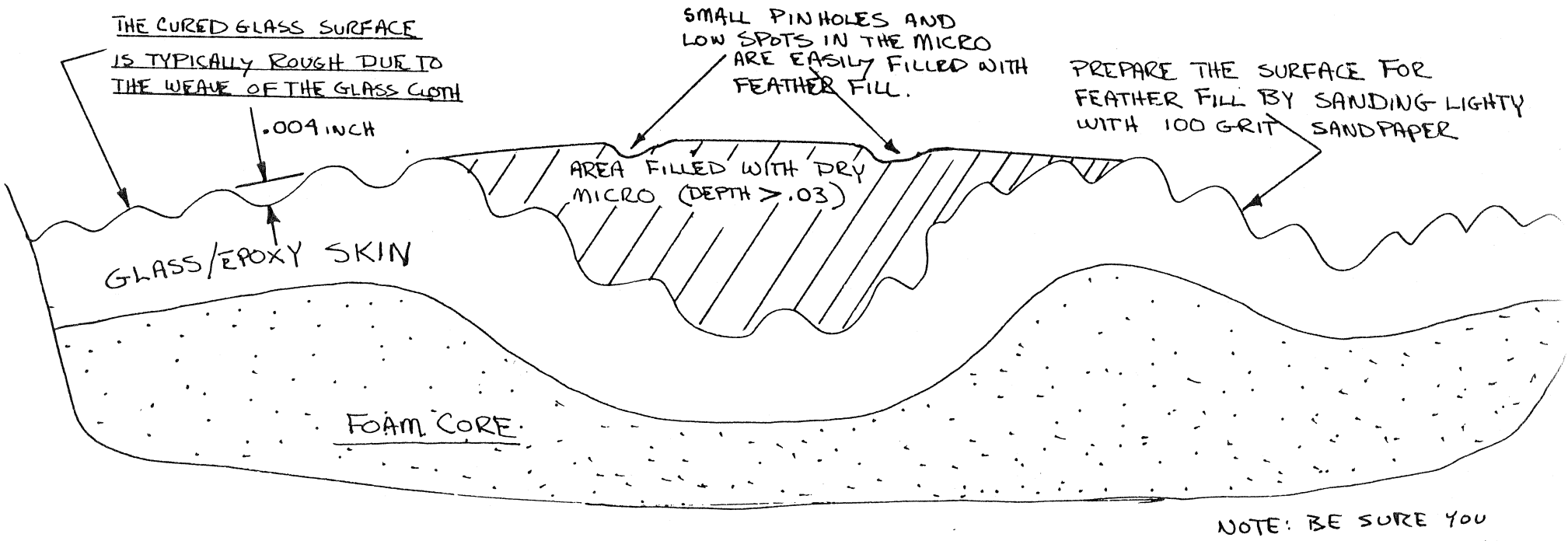
WHERE OVER .20 INCH FILL IS REQUIRED USE A URETHANE FOAM FILLER BLOCK



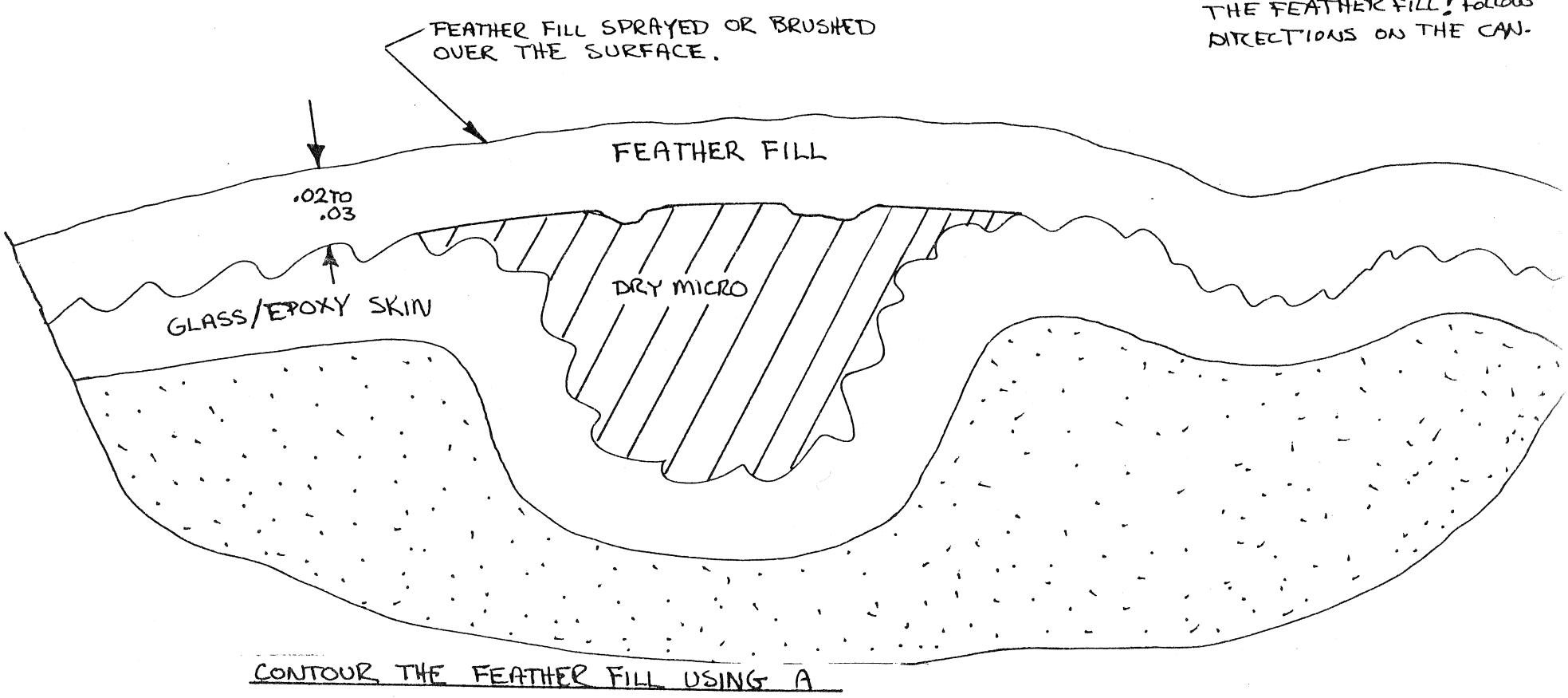
Step Three: Feather Fill

Sand the surfaces lightly by hand or with a soft foam sanding block in preparation for feather fill. A spray or brush coat of feather fill will build up .02" to .03" thick, fill the glass weave and any medium sized out of contour spots. Feather fill will require several hours curing time before it can be sanded. The cured feather fill is sanded to contour using a spline or soft block and 100-grit sandpaper. Again, extreme caution must be exercised not to damage the glass structure in persuit of a good finish. The contouring must stop immediately when the highest glass peaks begin to be visible as the feather fill is sanded away.

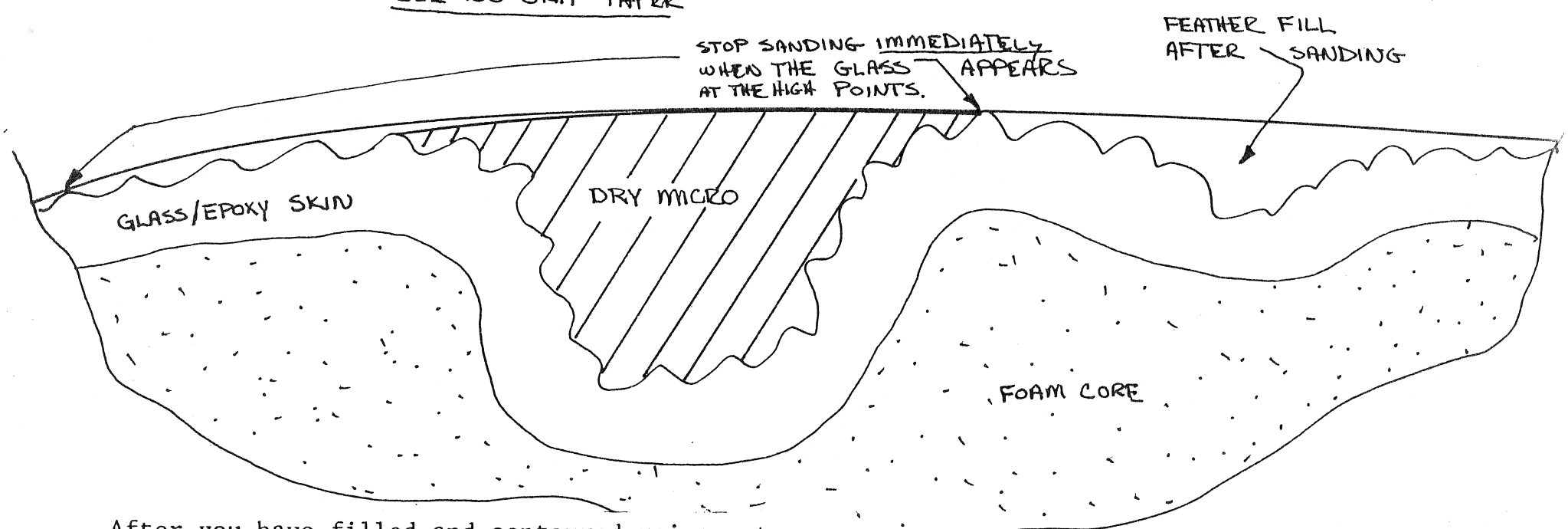
If you find that you have underestimated the fill required or just have a thin coat, don't hesitate to use a second coat of feather fill. A well prepared surface generally won't need more than one coat. When you have finished contouring the feather fill, the surface should be basically smooth and fair. The primer to follow is not intended to be contoured heavily, just smoothed with finer sandpaper for a smooth finish while leaving a substantial ultra violet barrier.



NOTE: BE SURE YOU MIX THE CATALYST IN THE FEATHER FILL! Follow DIRECTIONS ON THE CAN.



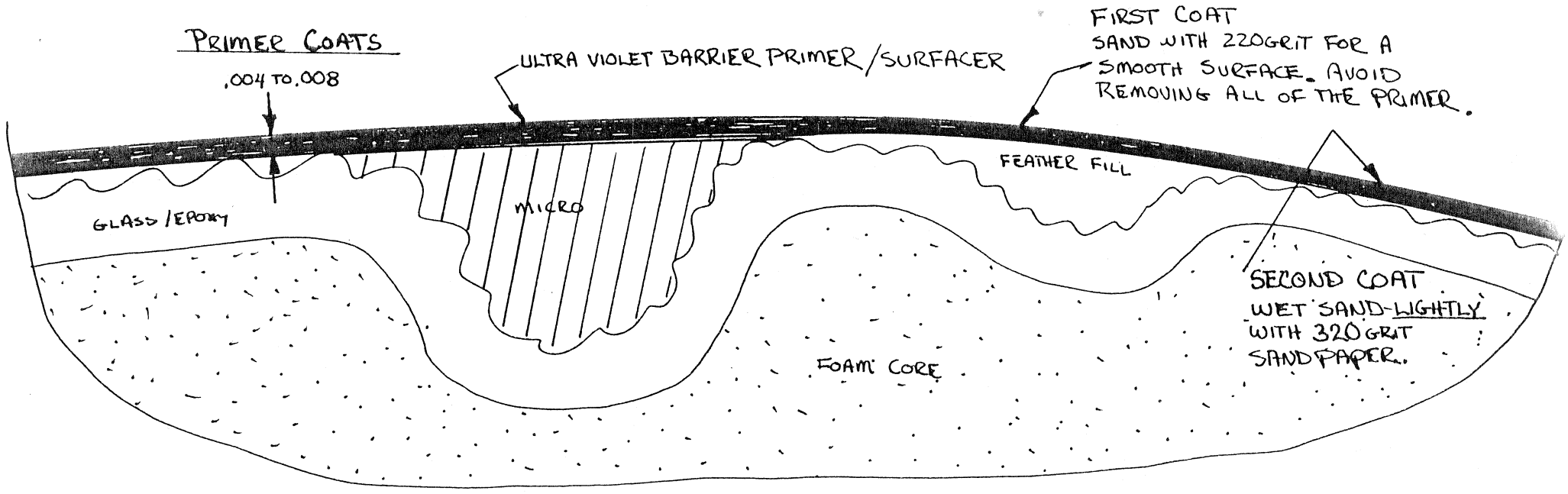
CONTOUR THE FEATHER FILL USING A SPLINE OR SOFT SANDING BLOCK
USE 100 GRIT PAPER



After you have filled and contoured reinspect for sanding damage, it is an easy thing to do! Remember you are only allowed to sand into the first skin ply in local areas no greater than 2 inches in diameter and all of these areas must total less than 10% of the surface area. Be careful!

Step Four: Primer

The ultra violet radiation barrier is provided by the heavy carbon black content of the dried primer (Dupont 70S). The primer gives the whole surface a flat black color and the sanding should never remove it completely, exposing the light gray feather fill below. The primer is sprayed on, allowed to dry, and sanded lightly to achieve a smooth surface. The first primer coat is sanded using 220-grit and the second coat very lightly wet sanded with 320-grit. When complete, the primer is very smooth, dark, and ready for finish paint.



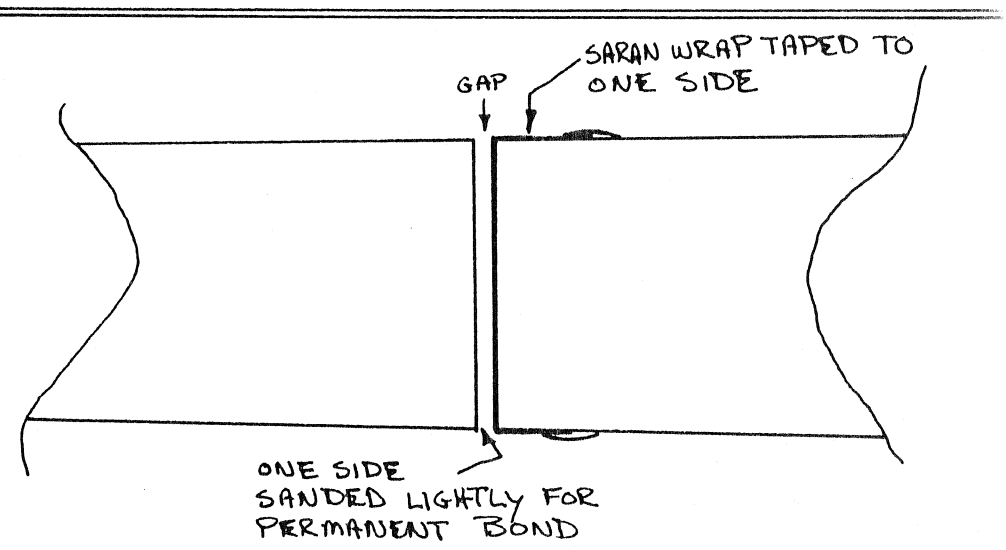
Step Five: Finish Paint

Follow the manufacturer's directions for the type of finish paint that you have chosen.

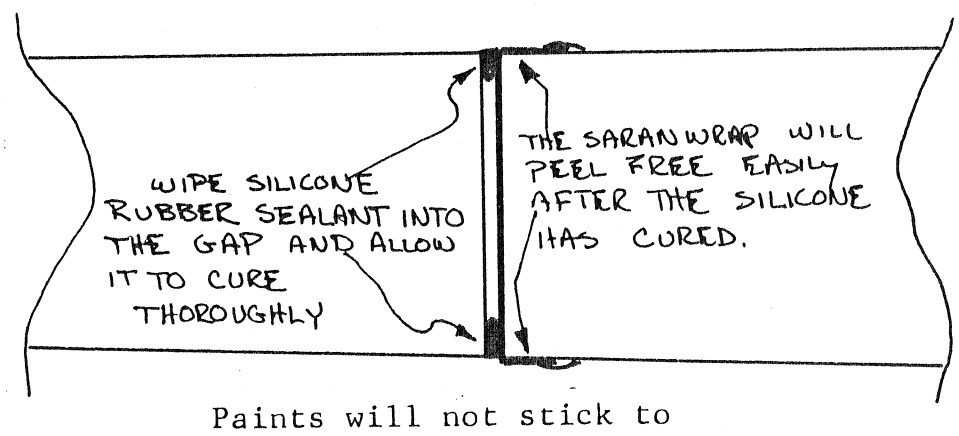
MISCELLANEOUS

Seals

Where a flexible, durable seal between two assemblies is required, white silicone rubber (RTV) is recommended. For a removable seal, such as between the wing root and fuselage, or canard and fuselage, one side of the seal is bonded to the part and the other side is treated before application of the sealant so that it can't adhere. A simple release can be achieved by taping Saran Wrap tightly over one side of the joint. The seal is installed by assembling the two components with Saran Wrap protecting one side, lightly sanding the other, and then wiping the wet silicone into the gap. Remove all excess silicone at the surface. This assembly has to dry for at least two days before the parts are disassembled. The Saran Wrap will easily peel off of the cured silicone.

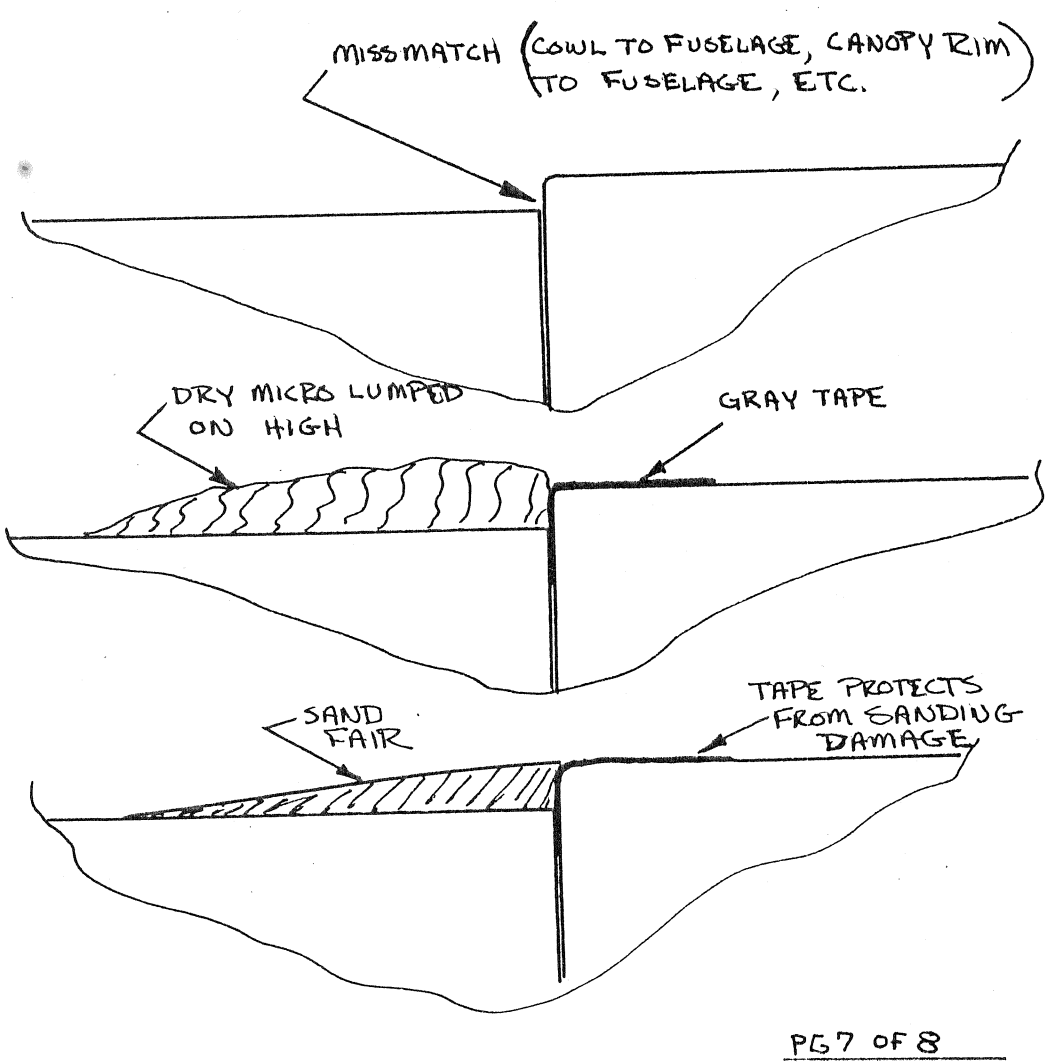


SILICONE RUBBER GAP SEAL



Paints will not stick to the silicone rubber, so choose a compatible color(white).

Mismatch Treatment



Cockpit Interior Paint

You may use colored cockpit interior paint to suit your own taste. For example, gray was used on the prototype N4EZ. It is not necessary to fill the glass weave and some very light sanding may be done to smooth the surfaces slightly. Apply one coat of the Dupont 70S primer to the interior glass surfaces for ultra violet protection and color to suit over that. Be sure to mask the nose gear window and fuel guages before painting.

N-Numbers (Registration Marks)

You may use adhesive type letters and numbers or paint your registration marks directly on the airplane; your choice. Some simple hints may save some trouble on either method. When installing the self-adhesive type, first use Windex window cleaner to wet the area where you want the markings, strip the protective backing off the letter or number, and apply it to the wet surface. The Windex will allow you to slide the markings around for perfect postioning, and then when located properly, just press them down lightly. The pressure squeezes the Windex out and allows the adhesive to bond to the airplane. If you paint the registration marks directly onto your airplane, first mask off the outlines for painting, then sand lightly with 320-grit sandpaper, then paint and remove the masking tape.

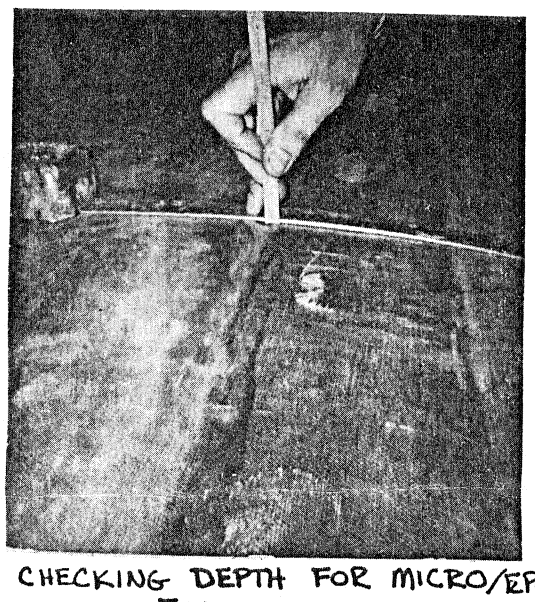
BILL OF MATERIALS

Sandpapers:
9" X 11" sheets, Silicon Carbide or Aluminum Oxide types.
Coarse - 36, 40, or 60 grit
Medium - 100 or 150 grit
Fine - 220 and 320 grit

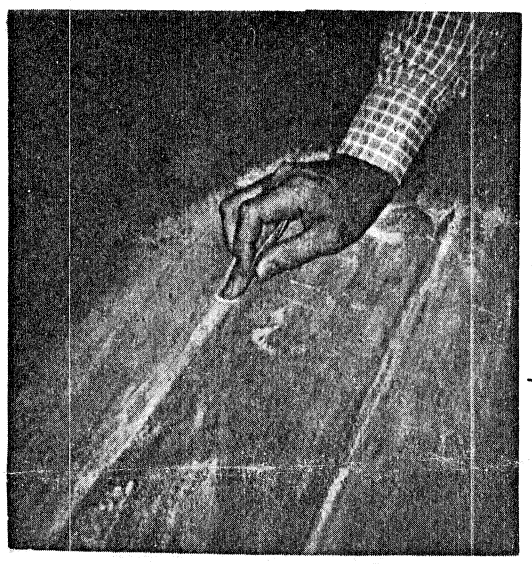
*Filler Materials:
RAEF epoxy
PF grade inorganic Quartz Microspheres
Feather Fill (6 quarts with catalyst)

Primer:
DuPont 70 S dark gray laquer primer surfacer (2 to 3 gallons)

Paint:
*Henco-Lac E-7610, NUL-V, Brilliant White Acrylic Laquer.
-OR-
Finish paint of your choice.
*These materials are available through VariEze distributors, the remainder are available locally in most areas through auto parts suppliers.

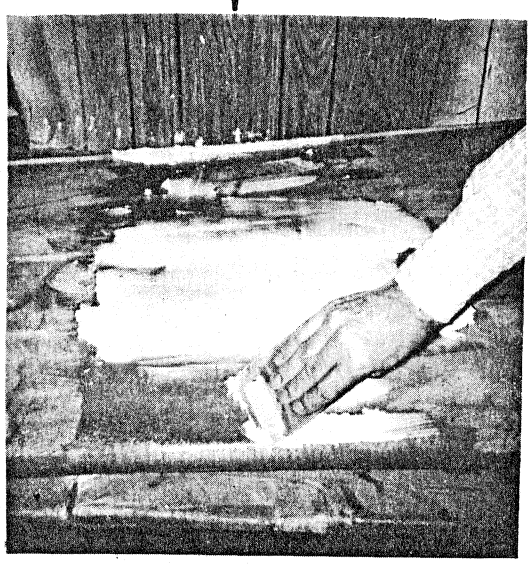


CHECKING DEPTH FOR MICRO/EPOXY FILL

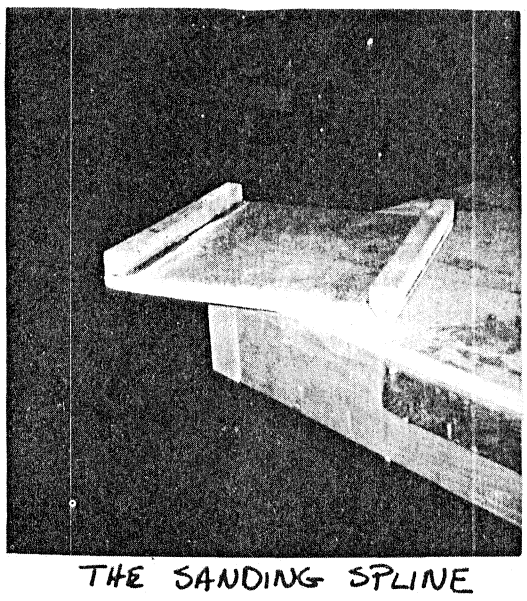


HAND SANDING IN PREP FOR MICRO/EPOXY FILLER

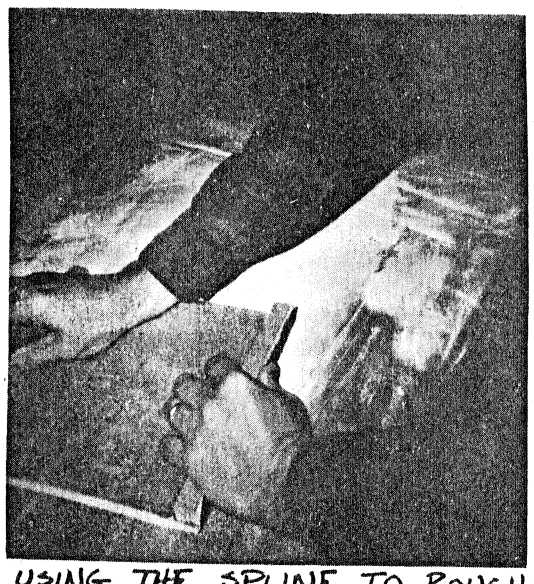
PAINTING A LIGHT COAT OFF EPOXY



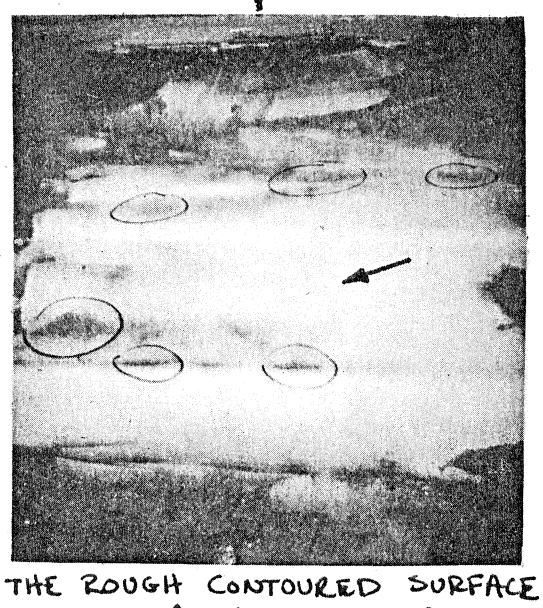
LUMPING MICRO ON HIGH



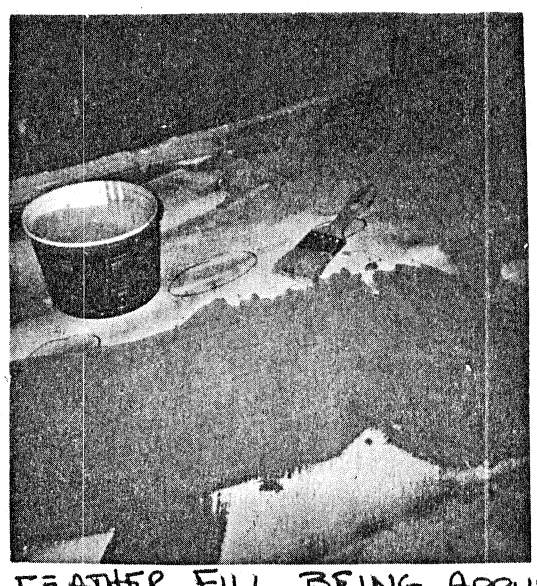
THE SANDING SPLINE



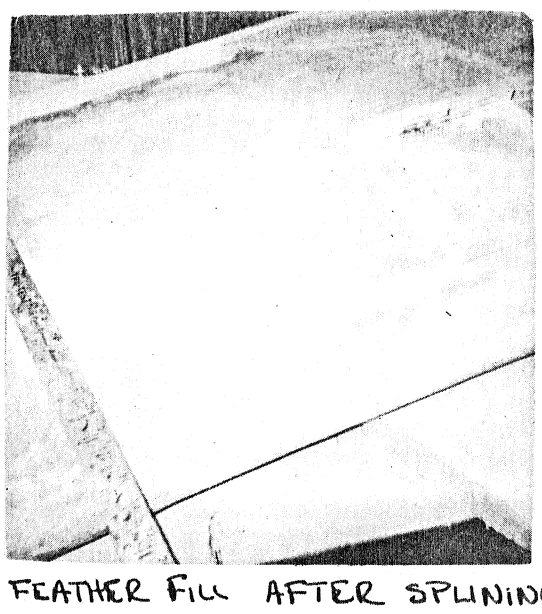
USING THE SPLINE TO ROUGH CONTOUR THE MICRO FILL



THE ROUGH CONTOURED SURFACE. CIRCLED AREAS ARE GLASS PEAKS BEGINNING TO APPEAR.



FEATHER FILL BEING APPLIED BY BRUSH.



FEATHER FILL AFTER SPLINING WITH MEDIUM SANDPAPER.